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PIEZO-OPTICAL DETERMINATIONS OF DEFORMATION POTENTIALS RELEVANT--ETC(U)
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STATUS REPORT

PIEZO-OPTICAL DETERMINATIONS OF DEFORMATION POTENTIALS RELEVANT TO TRANSPORT PROPERTIES CALCULATIONS OF MULTIVALLEY SEMICONDUCTORS

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STATUS REPORT

PIEZO-OPTICAL DETERMINATIONS OF DEFORMATION POTENTIALS RELEVANT TO TRANSPORT PROPERTIES CALCULATIONS OF MULTIVALLEY SEMICONDUCTORS

An investigation of the stress-dependence of the indirect absorption edge in semiconductors such as Si can yield information concerning the relative contributions of the phonon-assisted electron and hole scattering mechanisms to the absorption mechanism. Once the relative coefficients are known a fit to the absorption coefficient can be made in order to determine the absolute values for electron-phonon and hole-phonon deformation potentials. It has been demonstrated that in the case of Si these two processes are affected differently by the applied stress and hence it is possible to separate them[1]. Utilizing the sensitive technique of wave-length modulated transmission we have undertaken an investigation of the stress-dependent intensities of the indirect transition in Si.

The transmitted intensity can be written as:

$$I_T = I_o(1-R)\ e^{-\alpha t} \tag{1}$$

where I_o is the incident intensity, R the reflectivity, α is the absorption coefficient and t is the thickness of the sample. Taking the wave-length derivative of Eq.(4) one obtains (R is not λ - dependent in this region):

$$\frac{dI_T}{d\lambda} = -\ I_o(1-R)\ e^{-\alpha t}\ [\ -t\ \frac{d\alpha}{d\lambda}] \tag{2}$$

and hence dividing Eq. (2) by Eq.(1) one obtains the normalized derivative:

$$\frac{dI_T}{d\lambda}/I_T = -t\ \frac{d\alpha}{d\lambda}\ , \tag{3}$$

which is the quantity of interest.

During the first period we have constructed an optical, stress and cryogenic system to measure the stress and spectral dependence of Eq. (3) at $77^{o}K$, at which temperature there is a strong excitonic indirect absorption edge. Shown in Fig. 1 is the normalized wavelength modulated absorption spectra of Si at $77^{o}K$ for stress $X = 0$. The zero stress-background is taken to be a smooth line so as to isolate the sharper portions of the structure observed between 1.02 and 1.03μ (hatched area). In Fig. 2 is shown the spectrum for $X = 2.82 \times 10^{9}$ dyn cm^{-2} along [110] with light incident on a [111] face and polarized parallel (ll) to the stress axis. The peaks (hatched areas marked C_1, C_2, C_3 and C_4) have been differential from the background. By means of a planimeter we have measured the integrated intensities (hatched areas) as a function of stress. In Fig. 3 is shown the stress-dependence of peak C_1 for light polarized ll to the stress-axis. The stress-dependence of these peaks will be fitted to the expression in Table I and Eq. (B1) of Ref. 1 in order to determine the relevant deformation potentials.

We have constructed the optical, stress and cryogenic apparatus necessary to perform this experiment and have already obtained the relevant data for several stress directions. Several other stress directions and polarization configurations are required before all the data is acquired to perform the appropriate fitting procedures.

<u>Reference</u>

1. L. D. Laude, F.H. Pollak and M. Cardona, Phys.Rev. <u>B3</u>, 2623 ~~(1971)~~.

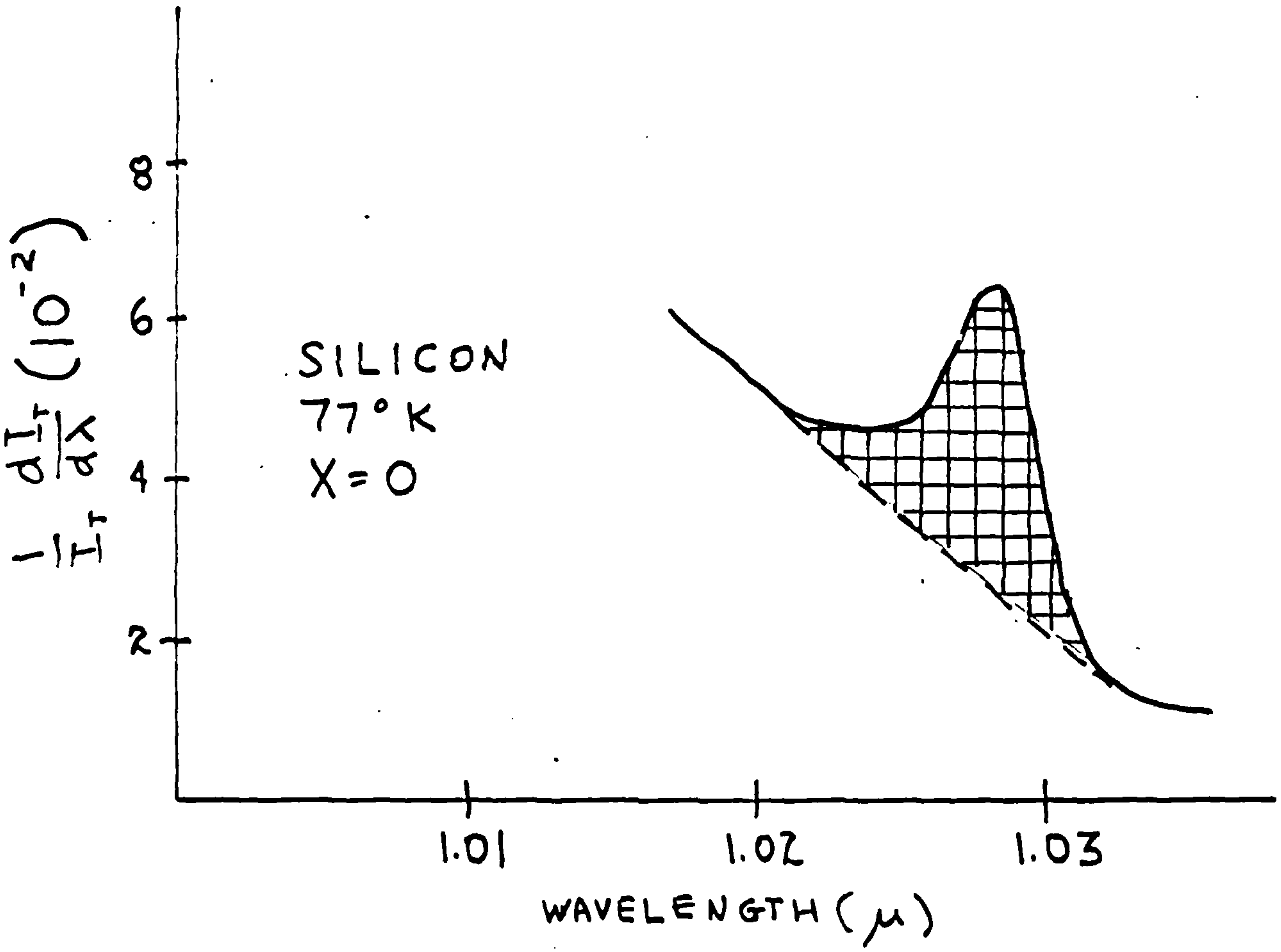

Fig. 1 Normalized wavelength - modulated absorption spectra of silicon at 77°K for stress X = 0. The X = 0 background is taken to be a smooth line so as to isolate the sharper portions of the spectra (hatched areas).

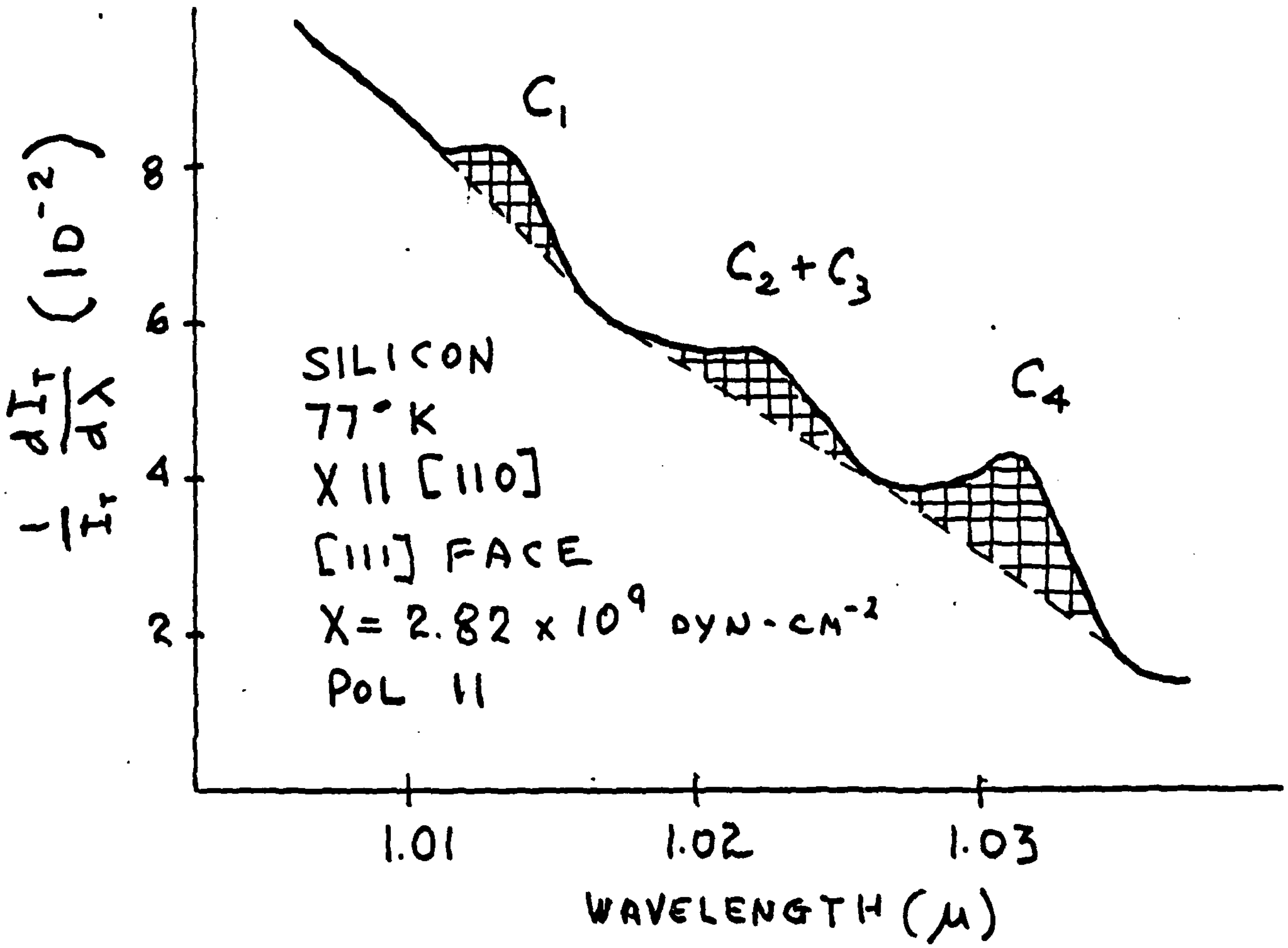

Fig. 2. Normalized wavelength - modulated absorption spectra of silicon at 77^{o}K for $X = 2.82 \times 10^{9}$ dyn cm^{-2} along [110] with the light polarized parallel ($\parallel$) to the stress axis. The notation of the peaks C_1, C_2, C_3 and C_4 is from Ref. 1.

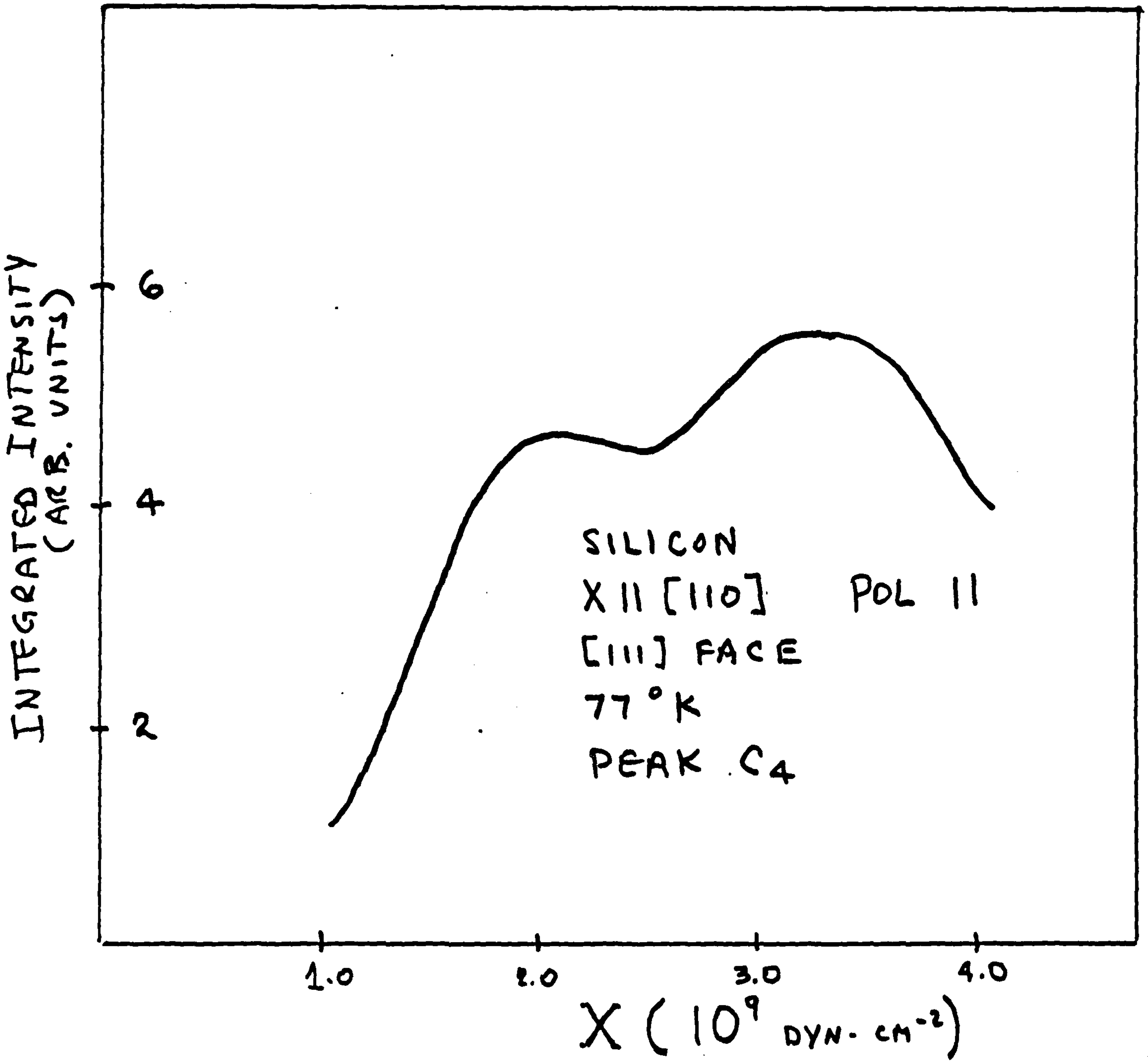

Fig. 3 Integrated intensity (i.e. hatched area) of peak C_4 as a function of $X \parallel [110]$ for light polarized parallel ($\parallel$) to the stress axis.

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